

National Aeronautics and Space Administration



Methyl Chloride from Aura MLS: Global Climatology and Assessment of Daily through Interannual Variability in the UTLS

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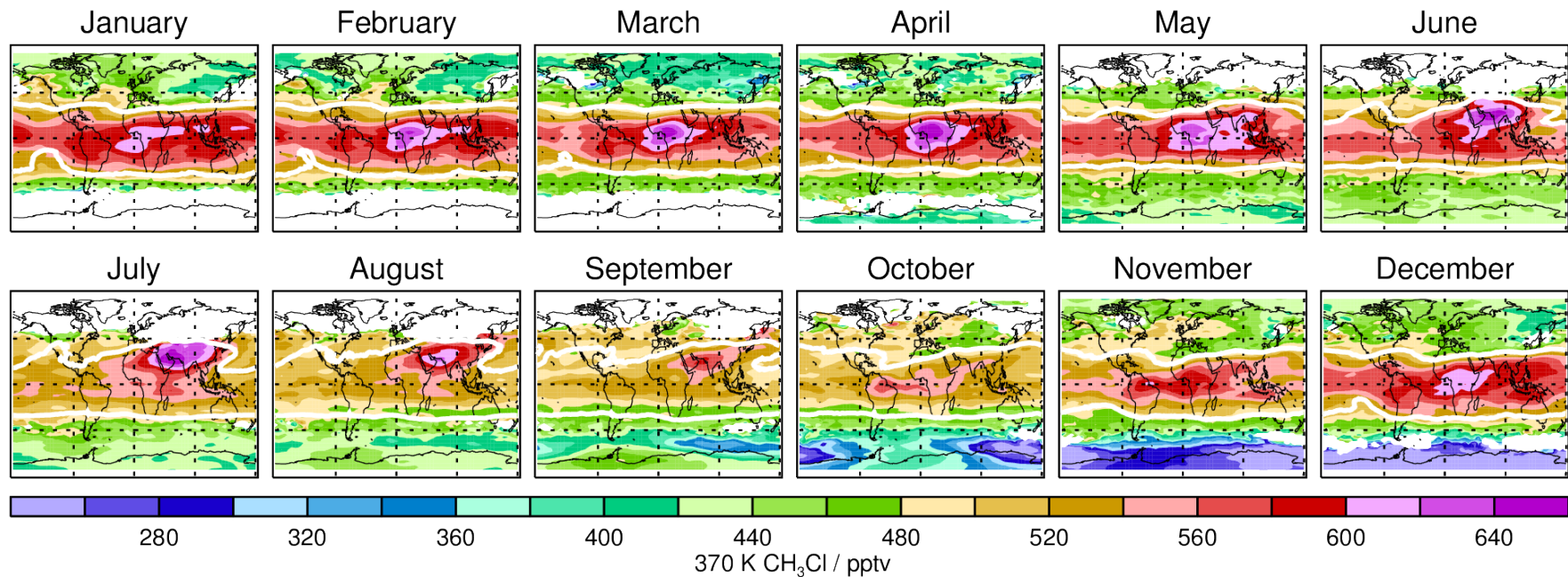
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Methyl Chloride: Introduction and Motivation

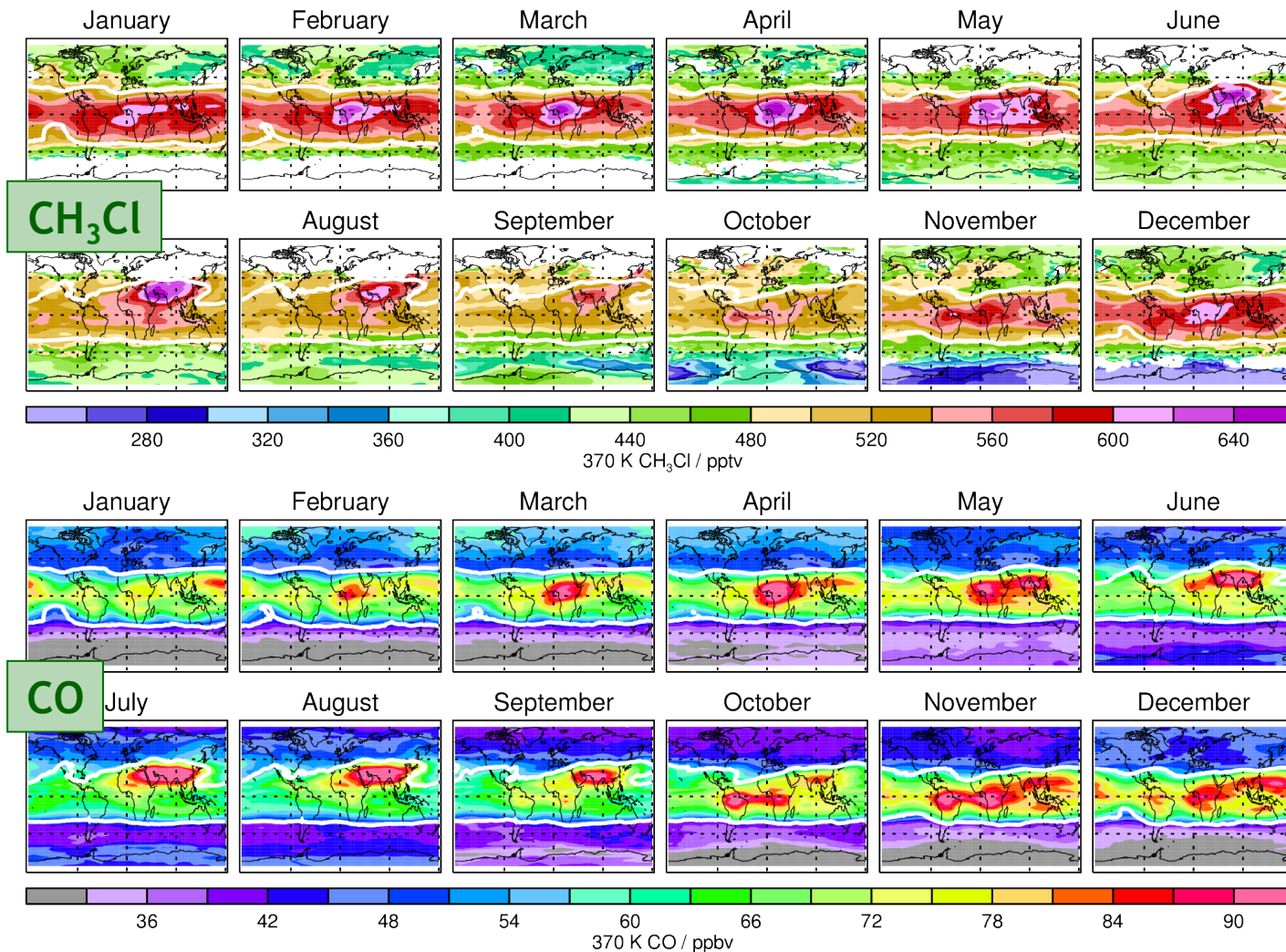
- ◆ As the largest natural source of stratospheric chlorine, methyl chloride (CH_3Cl) currently accounts for ~16% of chlorine-catalyzed ozone destruction in the stratosphere
- ◆ Sources include: tropical and subtropical plants, dead plant matter, tropical oceans, salt marshes, wetlands, wood-rotting fungi; biofuel and biomass burning account for ~25% of its global source strength
- ◆ CH_3Cl will likely increase in importance as anthropogenic halocarbons decline in response to regulations (e.g., the Montreal Protocol); changes in climate and land use patterns may also impact CH_3Cl input to and uptake from the atmosphere
- ◆ Thus a quantitative understanding of the CH_3Cl distribution and its variability will establish a valuable baseline against which its future stratospheric burden may be assessed
- ◆ With the release of the version 3 (v3.3) data set, Aura MLS now provides the first daily global observations of CH_3Cl
- ◆ The unprecedented scope of the multi-year MLS data set makes it uniquely suited to studying the spatial, seasonal, interannual, and longer-term variations in the distribution of CH_3Cl in the UTLS

Spatial and Seasonal Variations of CH₃Cl in the UTLS



- ◆ Climatological (2005-2011) monthly mean maps of CH₃Cl at 370 K (~147 hPa, ~12 km) show large spatial and seasonal variations that are related to variations in its surface sources and in convection - which can inject CH₃Cl from biomass burning into the UT very rapidly
- ◆ Seasonal biomass burning “hotspots” are generally reflected in UT values
 - ▲ South America & Africa south of the equator: May/June to December
 - ▲ Africa north of the equator: October to April
 - ▲ India & Southeast Asia: January through May

Correlation Between CH_3Cl and CO in the UTLS

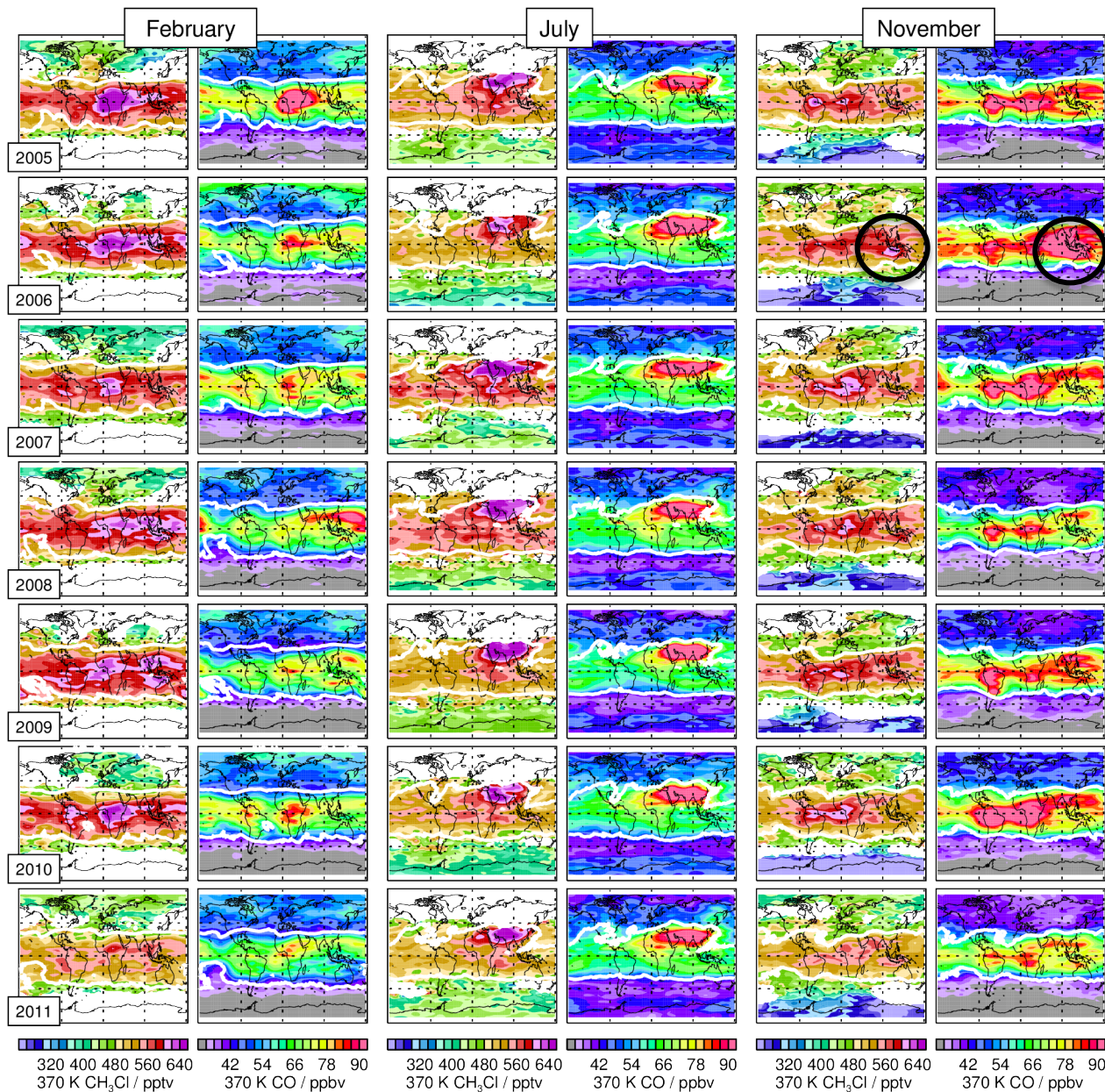


◆ MLS CH_3Cl and CO monthly mean maps in the UTLS show very similar patterns

◆ Both are controlled by the interplay between emissions, convection, and long-range horizontal transport

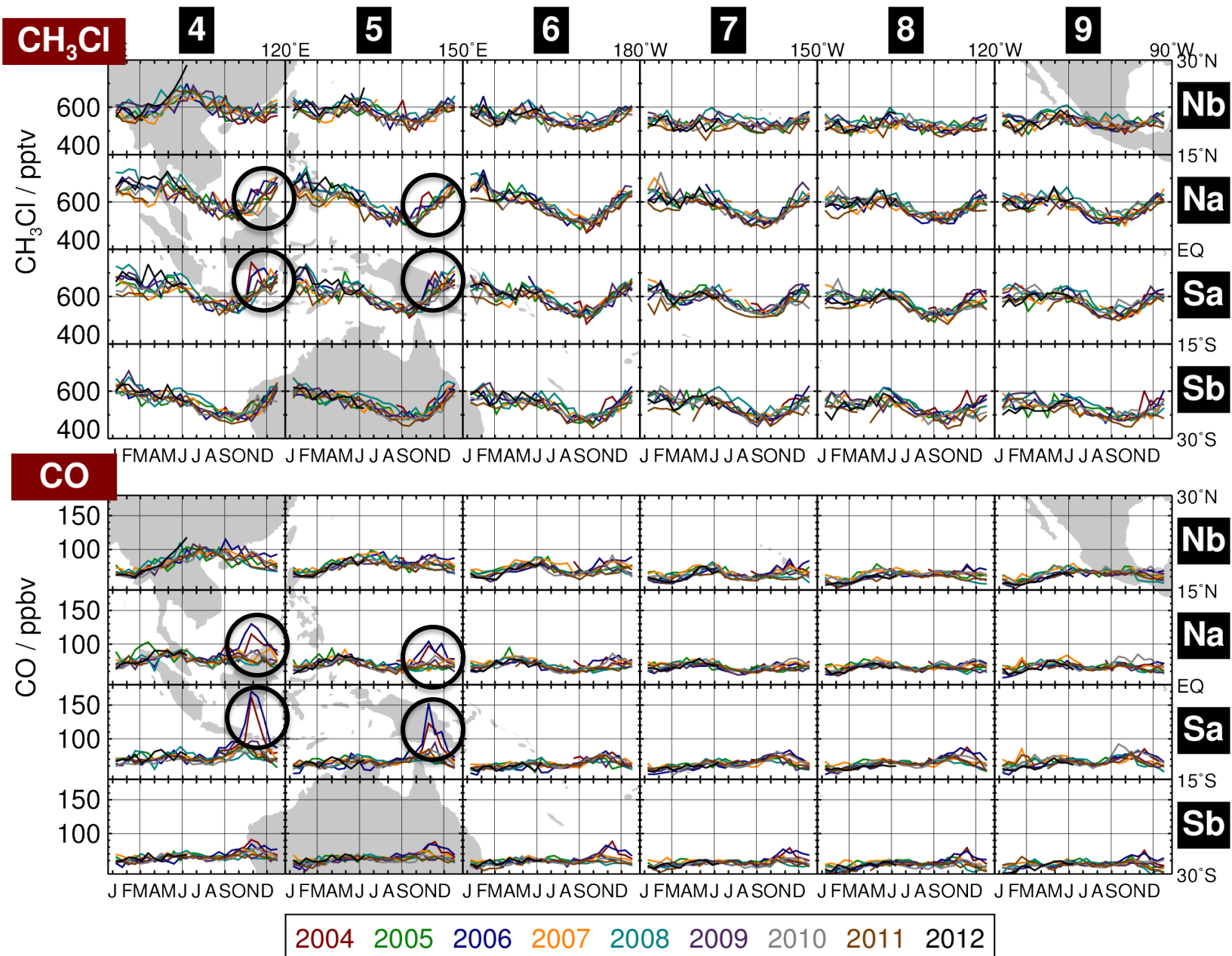
- ◆ CO has both biomass burning and industrial sources
- ◆ CH_3Cl provides valuable constraints on transport and may help to distinguish biomass burning from industrial emissions

Interannual Variations of CH₃Cl and CO in the UTLS (370 K)

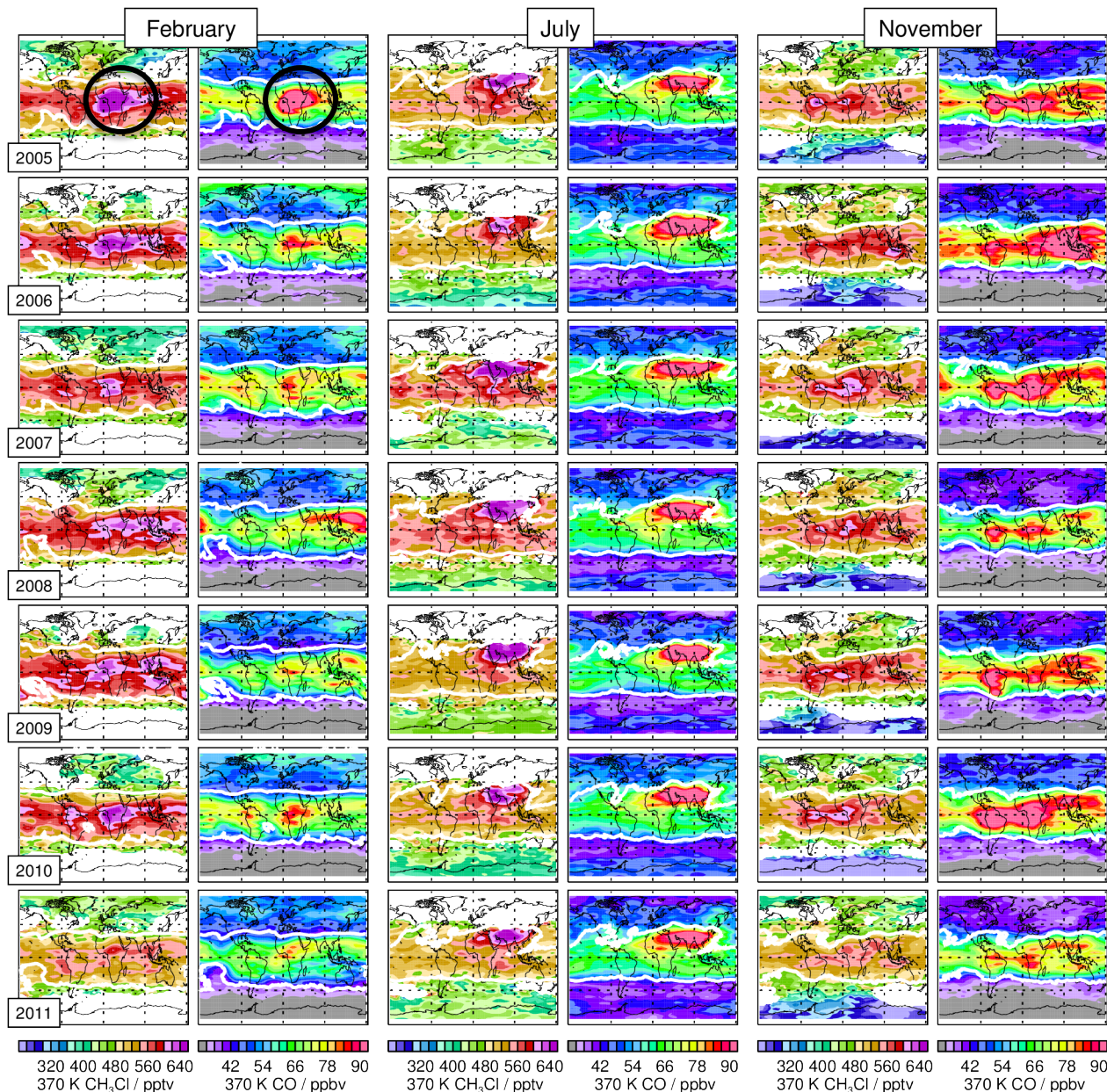


- ◆ Many features recur every year, but strong enhancements present in some years are weak or absent in others
- ◆ For example, enhancements over Indonesia in November 2006 are associated with the moderate El Niño that year

Interannual Variations of CH₃Cl and CO in the UTLS (147 hPa)

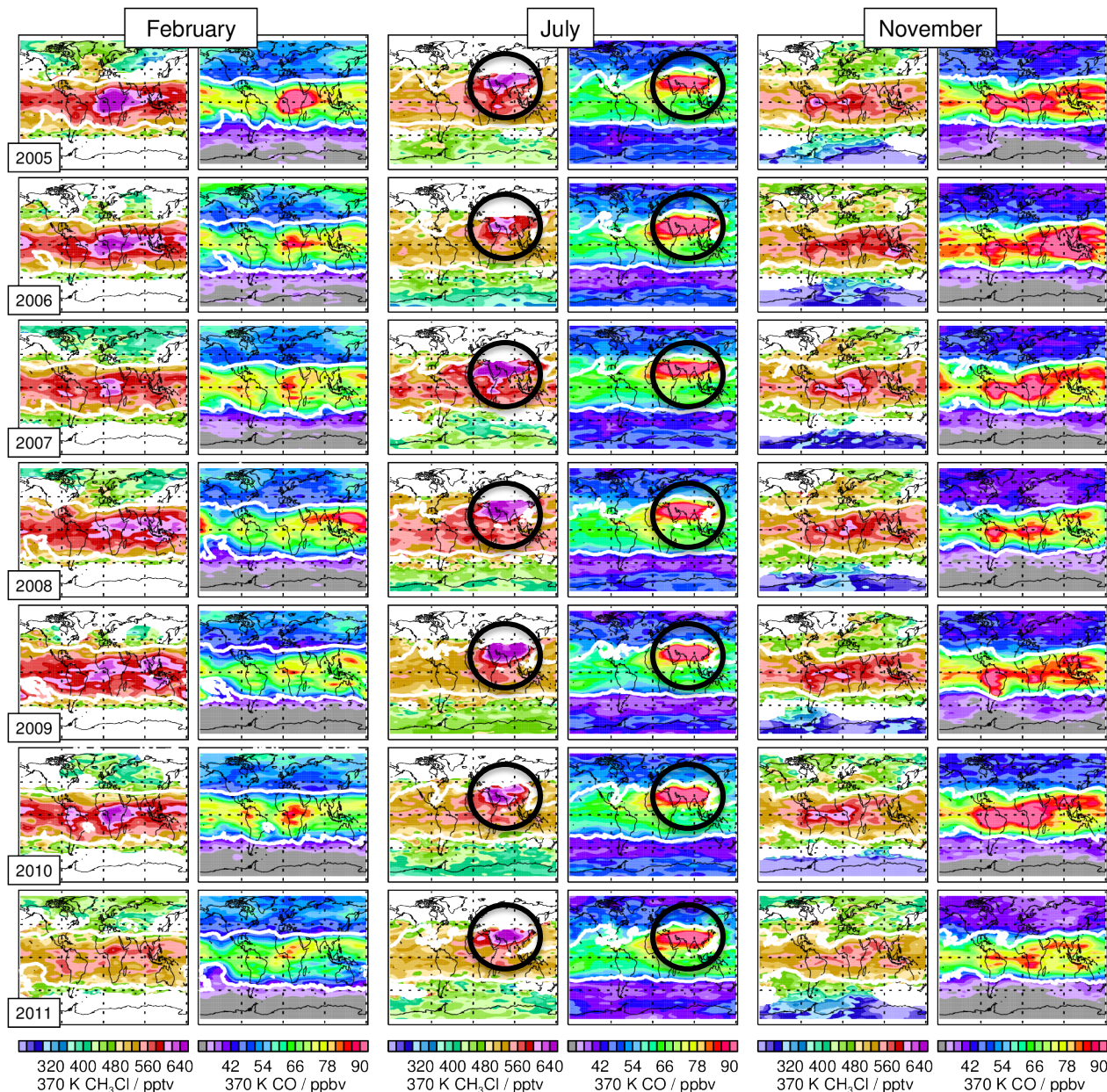


Interannual Variations of CH₃Cl and CO in the UTLS (370 K)



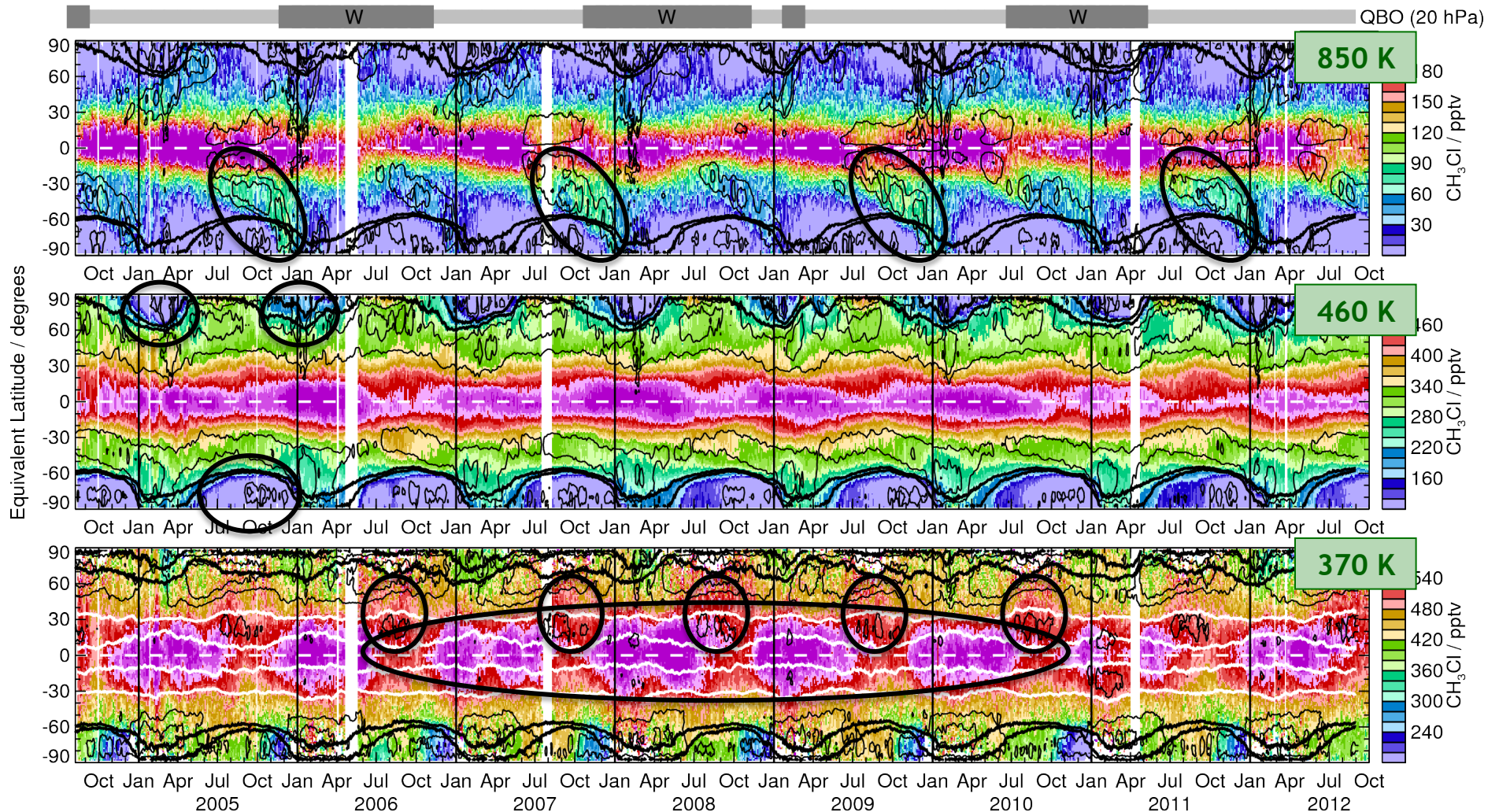
- ◆ Enhancements are common over central Africa in February, but those in 2005 are the strongest in the MLS record
- ◆ MLS measurements of cloud ice water content (IWC) suggest that deep convection may have been anomalously strong at that time

Interannual Variations of CH₃Cl and CO in the UTLS (370 K)



- ◆ The most repeatable and persistent strong enhancement in both species occurs over Asia from June to September
- ◆ Pollution transported upward by deep convection over this region becomes trapped within the Asian summer monsoon anticyclone in the UTLS

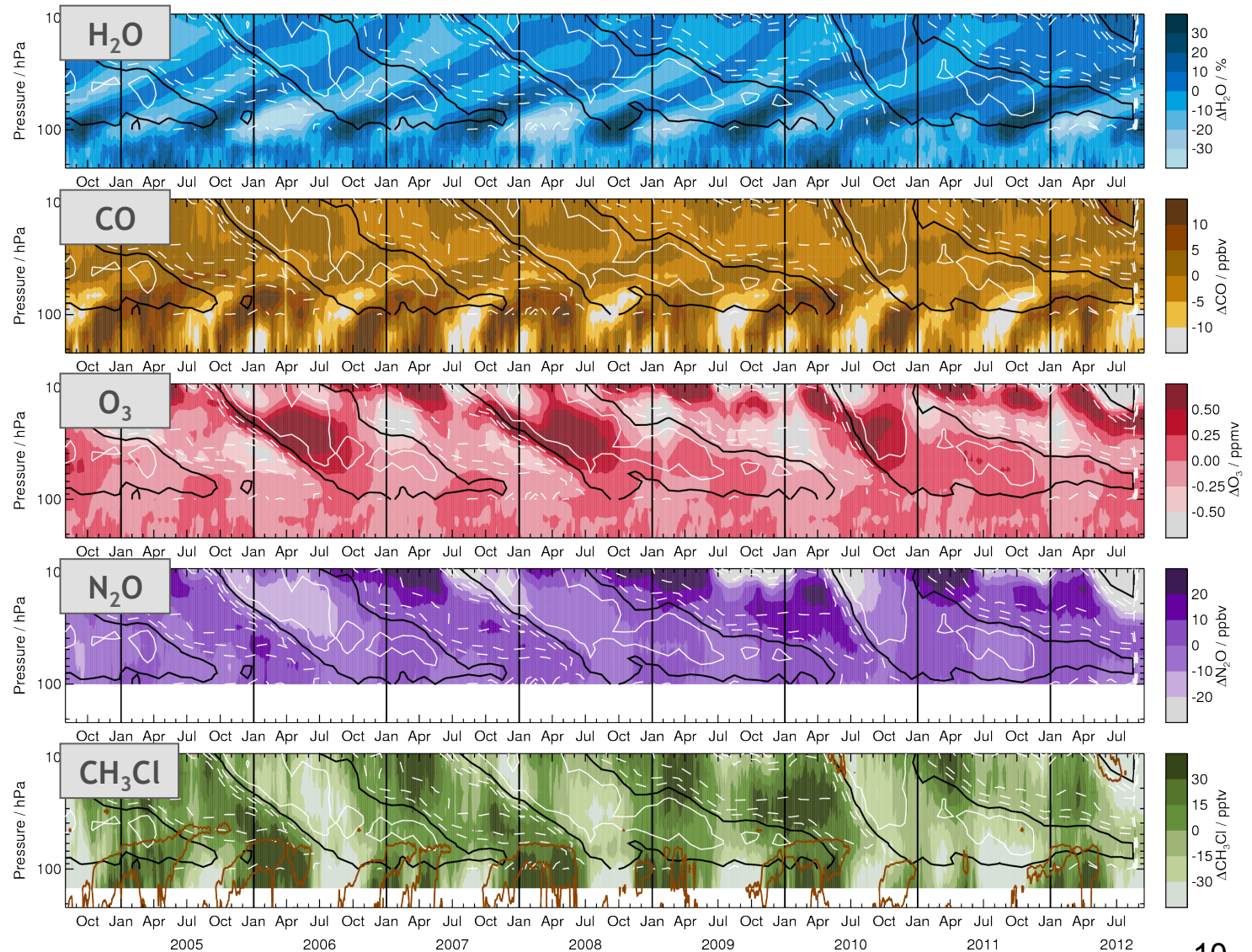
Temporal Evolution of CH₃Cl



- ◆ CH₃Cl exhibits substantial seasonal and interannual variations throughout the upper troposphere and stratosphere (e.g., descent in the winter polar vortices, cross-tropopause mixing, QBO)

QBO / Tropical Tape Recorder Signatures in CH_3Cl

- ◆ H_2O and CO show clear “tape recorder”-like effects, but little or no QBO
- ◆ O_3 and N_2O show clear QBO effects
- ◆ CH_3Cl seems to reflect a superposition of both, with a fairly clear QBO signal at higher levels merging into an annual cycle at lower levels resembling a tape-recorder variation



Methyl Chloride: Summary & Future Work

- ◆ Methyl chloride, CH_3Cl , is the predominant natural carrier of chlorine to the stratosphere
- ◆ Increases in CH_3Cl through changes in climate, land use or biomass burning could potentially offset some of the projected decline in anthropogenic chlorine
- ◆ Aura MLS is now providing the first daily global measurements of CH_3Cl , characterizing its distribution and daily through interannual variability in the upper troposphere and stratosphere
- ◆ MLS CH_3Cl data are useful over the range 147-4.6 hPa; single-profile precision is 100 pptv; vertical resolution is 4-6 km in the UTLS
- ◆ MLS CH_3Cl is valuable as a tracer of transport in the UTLS
- ◆ We are comparing the distribution of CH_3Cl near the tropopause, and the variations therein, to those of other biomass burning products measured by MLS (CO , HCN , CH_3CN)
- ◆ Model studies are planned to evaluate the relative influence of surface emissions and vertical transport and convection on trace gas distributions at the tropopause and in the lower stratosphere